M.Sc. 3rd Semester Examination, 2011

PHYSICS

PAPER—PHS-303 (A & B)

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

Use separate scripts for Gr. A and B

PAPER—PHS-303 A

[*Marks* : 20]

Answer **Q. No. 1** and any *one* from the rest :

1. Answer any *five* bits : 2 × 5

(*a*) Write mass and energy relation with B.E. terms of nuclides for ${}_{Z}X_{N}^{A}$ and mention in each B.E. correction terms.

(*b*) What do you mean by electric quadruple moment of a nucleus ?

(*c*) Draw a block diagram presenting in each block of Rabi's method for determination of magnetic moments of nuclei.

(*d*) Write the name with example of the following even A nuclei :

(*i*) ${}_{Z}X_{7}^{A}$ and ${}_{Z_1}Y_{8}^{A}$

(*ii*) ${}_{Z_1}X_{45}^{A_1}$ and ${}_{Z_1}X_{45}^{A_1}$

(*e*) Write the various applications of mass spectrometer in modern science.

(*f*) Discuss the selection rules in multiple γ transition based on the intrinsic spin and parity.

(*g*) Express the different modes of γ-emission.

(*h*) What do you mean by recist free gamma ray spectroscopy ?

2. Give a brief account of Gamow's tunneling mechanism for alpha emission and hence obtain an expression for the decay costant λ in terms of the kinetic energy of alpha particles. 2 + 8

3. (*a*) Graphically show the continuous energy spectrum of the β particles in nuclear beta-decay and indicate the end point energy.

(*b*) Following Fermi's theory of beta decay, find out the probability per unit time for the emission of an electron (β^-) in the momentum range p_e and $p_e + dp_e$. 2 + 8

PAPER—PHS-303 B

(*Particle Physics*)

[*Marks* : 20]

Answer **Q. No. 1** and any *one* from the rest

1. Answer any *five* bits : 2 × 5

Justify the following statements :

(*a*) The strangeness scheme proposed by Gell-Mann, Nishijima and Nakono explains the behaviour of the strange particles.

(*b*) A conservation law arises due to a symmetry respected by an interaction where the symmetry operation is a unitary operator.

(*c*) $\eta \rightarrow \pi^{o} + \gamma$

$\pi^{o} \rightarrow \gamma + \gamma$

Are these reactions are allowed or forbidden by charge-conjugation parity ?

(*d*) Assuming isospin invariance in strong interaction, show that the proton and the neutron have same mass.

(*e*) Show that a massless Dirac particle has definite helicity.

(*f*) The eigenvalue of the charge conjugation operator of a system of fermion-antifermion is $(-1)^{l+s}$ where l is the relative orbital angular momentum s is the total spin of the system.

(*g*) Show that, while the parity operation is described by a unitary operator, time reversal is described by an antiunitary operator.

2. (*a*) State the reasons for postulating the principle of charge independence in strong interaction and how it leads to assume isospin for a strongly interacting particle. 2

(*b*) Assuming the principle of charge independence show that, for pi-meson nucleon scattering near Δ (1232) resonance $\sigma(\pi^+p \rightarrow \pi^+p) : \sigma(\pi^-p \rightarrow \pi^-p) : \sigma(\pi^-p \rightarrow \pi^0n) = 9 : 1 : 2$ where σ denotes the total cross-section for the process in the parenthesis. 8

3. (*a*) Why is it necessary to introduce the colour degrees of freedom for each quark flavour ? 2

(*b*) Assuming SU(3) flavour symmetry for light quarks, show how the existence of eight $J^P = 0^+$ mesons and eight $J^P = \frac{1}{2}^+$ baryons can be understood on the basis of quark models of hadrons. 5

(*c*) Explain proper and improper symmetry also symmetry breaking in particle physics. 3
